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## Maternal drinking behavior and Fetal Alcohol Spectrum Disorders in adolescents with criminal behavior in southern Brazil

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### Abstract

Prenatal alcohol exposure can have serious and permanent adverse effects. The developing brain is the most vulnerable organ to the insults of prenatal alcohol exposure. A behavioral phenotype of prenatal alcohol exposure including conduct disorders is also described. This study on a sample of Brazilian adolescents convicted for criminal behavior aimed to evaluate possible clinical features of Fetal Alcohol Syndrome (FAS). These were compared to a control group of school adolescents, as well as tested for other environmental risk factors for antisocial behavior. A sample of 262 institutionalized male adolescents due to criminal behavior and 154 male students aged between 13 and 21 years comprised the study population. Maternal use of alcohol was admitted by 48.8% of the mothers of institutionalized adolescents and by 39.9% of the school students. In this sample of adolescents we could not identify individual cases with a clear diagnosis of FAS, but signs suggestive of FASD were more common in the institutionalized adolescents. Social factors like domestic and family violence were frequent in the risk group, this also being associated to maternal drinking during pregnancy. The inference is that in our sample, criminal behavior is more related to complex interactions between environmental and social issues including prenatal alcohol exposure.

**Keywords:** Prenatal alcohol exposure, fetal alcohol spectrum disorder, criminal behavior, conduct disorder, FAS, FASD.

### Introduction

Prenatal alcohol exposure can have serious and permanent adverse effects on children, with the most severe outcome being the Fetal Alcohol Syndrome (FAS). It is characterized by a dysmorphic face with short palpebral fissure, smooth philtrum, and thin upper lip, pre- or postnatal growth deficiency, and central nervous system abnormalities. The intensity of these features varies and is manifested in a dose dependent fashion in a way that affected individuals can exhibit all the characteristics or only some of these. Thus, it constitutes a *continuum* of pattern that has been denoted as Fetal Alcohol Spectrum Disorder (FASD) (Jones *et al.*, 2010).

Research on alcohol teratogenesis has demonstrated that the developing brain is the organ which is most vulnerable to the effects of prenatal alcohol exposure (Goodlett and Horn, 2001). This teratogen acts in different ways depending on the type of brain cells and developmental stage of the embryo or fetus. It can lead to cell death, interfere with cellular functions, hinder the generation of new cells, cause abnormal cell migration and disorganized cell tissue structure, interfere in neurotransmitter production, and cause abnormal formation of neural synapses (Goodlett and Horn, 2001, Guerri *et al.*, 2009). Thus, there is no greatest period of vulnerability and all trimesters during pregnancy appear to be critical for normal brain development (Streissguth *et al.*, 1996).

Although the most common behavioral manifestation of the central nervous system alteration caused by prenatal alcohol exposure is a reduction in intellectual functions, deficits in social behavior are becoming a widespread mark in FASD individuals (Spohr *et al.*, 2007; Kelly *et al.*, 2009).

Certain studies suggested that these children have behavioral and emotional difficulties that can interfere with their participation in home, school and social environments. Adolescents and adults often exhibit poor socialization and communication skills. The majority displays significant maladaptive behaviors such as impulsivity and inappropriate sexual behavior, and they are less likely to be living independently (Streissguth *et al.*, 1991; Baumbach, 2002; Fast and Conry, 2004; Spohr *et al.* 2007).

FASDs are frequently associated with impaired behavior, cognitive deficits and secondary disabilities, and more than 90% of affected individuals show mental health problems, disrupted school experience (60%), trouble with the law (60%), confinement (50%), inappropriate sexual behavior (50%) and alcohol/drug problems (30%) (Streissguth *et al.*, 1996). Children prenatally exposed to alcohol present deficits in all domains of adaptive functioning. Their conduct shows a pattern of behavior that is predominantly disruptive and overactive-inattentive which can not be explained simply by a lower IQ (Momino *et al.*, 2008; McGee *et al.*, 2009). These problematic behaviors occur in individuals that were prenatally exposed to alcohol, independent of whether they meet the criteria for FAS (Mattson *et al.*, 1998; McGee *et al.*, 2009).

Criminal behavior among adolescents is an important problem in Brazil (Phebo and Moura, 2005). We do not have information about the incidence of FAS/FASD in Brazil, and it is a question whether this condition could be contributing to the adverse conduct seen in our young population. This study aimed to evaluate a sample of institutionalized teenagers regarding maternal use of alcohol during pregnancy and incidence of physical signs of FAS. We also included in our analyses other environmental risk factors that could be related to antisocial behavior.

## Subjects and Methods

The sample consisted of institutionalized males from FASE (Socio-educative Foundation), in Porto Alegre, RS, Brazil, randomly collected during the period of January 2003 to June 2004. FASE is a public institution that holds all teenagers from 12 to 21 years that committed a crime and were condemned. The main crimes committed by institutionalized males were robbery (50%), murder (15%), theft (9%) and robbery followed by death (7%); so the only point that distinguishes them from subjects institutionalized in an adult correctional system is age.

The control group consisted of 145 male students attending either elementary or high school levels in three public schools in Porto Alegre, RS, Brazil. For both groups, males between the ages of 13 and 21 years whose parents or guardians agreed to sign the informed consent were selected as eligible for participation. An exclusion criterion was refusal to sign informed consent. Both groups had been classified as middle/low class.

FAS diagnostic signs were defined according the guidelines of the Institute of Medicine (Hoyme *et al.*, 2005), as follows: (i) intrauterine or postnatal growth deficiency with height and/or weight at less than the 10<sup>th</sup> percentile, (ii) craniofacial dysmorphology including smooth philtrum, thin vermillion, and small palpebral fissures, (iii) central nervous system damage that is either structural or neurological, and (iv) prenatal alcohol exposure, which may be confirmed, unknown, or disconfirmed. For this diagnosis, all study subjects were examined by a physician or a medical student trained in a standard protocol by a dysmorphologist. The physical examination consisted of measuring height, weight, head circumference, palpebral fissure length, inner canthal distance, and philtrum length.

A questionnaire was completed by the mother or by the legal guardian, focusing on alcohol consumption during pregnancy and other maternal characteristics chosen as an indication of the quality of the pregnancy, including pregnancy complications and family history of alcoholism. Due to the long delay since pregnancy, maternal recall of alcohol use was classified as 'none', 'light to moderate', or 'sporadic' meaning less than daily, and 'heavy' meaning daily use of alcohol or binge drinking during pregnancy.

Abortion attempts together with bleeding during pregnancy, delivery problems, and use of medicine were our indicators of pregnancy quality. Familial history included five other variables: mental retardation in the family, physical abuse of the child, positive history of domestic violence, relatives with drinking problems, and positive history of criminality in the family.

Raven's Standard Progressive Matrices, a non-verbal test, was used as the intelligence measurement tool (Raven, 2000).

Descriptive statistics and  $\chi^2$ -test were used to summarize and compare the profile of the studied population. Multiple logistic regression analysis was used to determine if the use of alcohol during pregnancy was associated with covariates. Continuous physical measurements and Ravens cognitive performance scores were compared using one-way ANOVA. Categorical measurements were compared using  $\chi^2$ -tests. Categorization of outcomes by photographic analysis also was by a  $\chi^2$ -test.

The Ethics Committee of Hospital de Clinicas de Porto Alegre approved this project and its informed consent form.

## Results

Maternal characteristics and family history in the group of institutionalized (FASE) adolescents and in the control group are shown in Table 1. Maternal interviews were possible in only 178 (68%) mothers. Prenatal alcohol use was reported by 48.4% of the mothers of FASE adolescents and by 39.9% of the mothers of the control group. This difference was not statistically significant. On the

**Table 1** - Pregnancy quality and familial history in adolescents with criminal behavior (FASE) and in the school students (controls).

Variables	FASE		Controls		p*
	N	%	n	%	
Drinking habits					
None	92	51.6	58	60.4	0.336
Sporadic	69	38.8	32	33.3	
Frequent	17	9.7	6	6.3	
Pregnancy events					
Abortion attempt	17	9.7	11	11.6	0.607
Bleeding	24	13.9	13	13.4	0.914
Delivery problem	23	13.2	8	8.1	0.198
Use of medicines	27	20.1	19	19.6	0.915
Breastfeeding	24	13.7	8	8.1	0.171
Other variables					
Domestic violence	67	37.6	12	12.4	< 0.001
Familial criminality	78	43.1	19	19.6	< 0.001
Child abuse	53	29.3	4	4.2	< 0.001
Familial alcoholism	95	65.5	65	66.3	0.896

\*Chi-square.

other hand, we could observe a higher frequency of violence indicators among the convicted adolescents' families, such as domestic violence between the parents, familial criminality, and child abuse.

To verify if the use of maternal alcohol during pregnancy was related to any of the mentioned variables, a multiple logistic regression test was applied. Table 2 shows the

**Table 2** - Multiple logistic regression of maternal characteristics and familial history related to alcohol consumption.

Variables	Odds ratio	IC 95% of the lowest value	p
Bleeding	0.21	0.057-0.741	0.016
Domestic violence	0.16	0.045-0.548	0.004
Familial criminality	5.31	2.135-13.216	< 0.001
Child abuse	5.86	1.538-22.366	0.010
Alcoholism in family	4.04	1.668-9.787	0.002

significant results only of this analysis conducted with the data of 147 families with a positive history of maternal use of alcohol. To minimize bias we used only maternal questionnaires data that contained no missing answers. Bleeding, domestic violence, familial criminality, child abuse, and alcoholism among family members were the five variables found to be associated with maternal alcohol use in this study, with the first two variables having an opposite odds ratio to prenatal alcohol exposition.

Table 3 shows the percentile distribution of physical measurements of the institutionalized males and the control group. For height and head circumference we used percentiles range for comparison. For other measures, means and standard error were used. Considering the hypothesis that FAS signs would be more frequent in convicted adolescents than in those frequenting regular school, we would expect significant differences between both groups. For height, inner canthal distance and intelligence points, the differences were in the expected direction. Head circumference and philtrum length did not differ between groups.

**Table 3** - FAS signs in adolescents with criminal behavior (FASE) and in the school students (controls).

Variable		FASE		Controls		p
		n	%	n	%	
Height	Up to 10 <sup>th</sup> percentile	69	37.7	16	11.2	< 0.001*
	11 <sup>th</sup> to 50 <sup>th</sup> percentile	130	57.8	60	42.0	
	Above 50 <sup>th</sup> percentile	26	11.5	67	46.8	
Head circumference	Up to 10 <sup>th</sup> percentile	18	8.0	8	5.6	0.610*
	11 <sup>th</sup> to 50 <sup>th</sup> percentile	60	26.7	36	25.2	
	Above 50 <sup>th</sup> percentile	147	65.3	99	69.2	
		Mean	SE	Mean	SE	
Right palpebral fissure length		2.86	0.017	2.73	0.021	< 0.001 <sup>†</sup>
Left palpebral fissure length		2.86	0.017	2.74	0.022	< 0.001 <sup>†</sup>
Inner canthal distance		3.19	0.018	3.11	0.023	0.014 <sup>†</sup>
Philtrum length		1.64	0.019	1.61	0.024	0.314 <sup>†</sup>
Intelligence points		32.95	0.735	38.43	0.831	< 0.001 <sup>†</sup>

Height and Head circumference are expressed in percentiles; IQ points according to Raven's standard progressive matrices; other measures in cm.

\*Chi-square.

<sup>†</sup>Analysis of variance SE: standard error.

More surprisingly however was the fact that palpebral fissure length was significantly smaller in control group.

We also performed a multivariate analysis (ANOVA) comparing physical measures and IQ points between FASE adolescents and school students, considering prenatal exposition to alcohol. This analysis further corroborated the results shown in Table 3.

To better understand this result we separately analyzed anthropometric variables that showed differences taking into account ethnic ancestry in institutionalized and control subjects (Table 4). We observed that mean palpebral fissure length was smaller only in controls classified as of European ancestry. Other measures did not show differences between individuals of different ethnic origins. Mean IQ points, however, were markedly lower only in FASE adolescents of European ancestry.

## Discussion

Our goal was to find out whether there was a prevalence of maternal use of alcohol during pregnancy and incidence of physical signs of FAS in confined young males. In other words we wanted to know how much FAS or fetal alcohol exposure (FAE) may be contributing to juvenile criminal behavior in our society. FAS and FASD are not rare in occidental societies. May *et al.* (2009) estimated that in the U.S., the prevalence of FAS is in the range of 2-7 per 1000, and for FASD their estimates were as high as 2-5% of school children in the US and Western Europe.

FASD is an umbrella term for a wide range of possible consequences of prenatal alcohol exposure. Although the physical expression of this syndrome is not always present, the damage caused in the brain and consequently in behavior is long lasting (Momino *et al.*, 2008). A current discussion in the literature presently is to better characterize the specific behavioral phenotype associated to FASD (Nash *et al.*, 2008; Kodituwakku, 2009), and more specifically criminal behavior. There are few studies in this area, but all of these agree that FAS in the criminal justice system is under diagnosed (Fast *et al.*, 1999; Burd *et al.*, 2004).

Some studies have identified a dose-response effect between prenatal alcohol exposure and behavioral problems taking together both the effects of environmental factors and prenatal alcohol exposure when evaluating the association with behavioral difficulties and psychiatric disorders in affected children (Hill *et al.*, 2000; O'Connor and Paley, 2006; Guerri *et al.*, 2009; Rodriguez *et al.*, 2009). A recent observational cohort study including 592 adolescents observed that those exposed to an average of one or more drinks of alcohol per day in the first trimester of pregnancy were three times more likely to meet criteria for a lifetime diagnosis of conduct disorders than were adolescents whose mothers drank less than that amount or abstained (Larkby *et al.*, 2011). A study performed by Staroselsky *et al.* (2009) showed that parental psychopathology and prenatal exposure to maternal alcohol can contribute to the child's behavioral phenotype.

We also included in our analyses, the presence of other environmental risk factors that could be related to criminal behavior. Maternal intake of alcohol was admitted by almost 48% of the mothers of adolescents with criminal behavior. Although this seems high, it was not different from the control group (40%). Data in the literature denote the use of alcohol in pregnancy from 28% to 41% in Brazil (Gama *et al.*, 2004). The 2009 Morbidity and Mortality Weekly Report (MMWR, 2009) showed that in the period from 1991 to 2005, approximately 12% of pregnant women used alcohol and near 1.9% engaged in binge drinking or frequent use of alcohol. Ethen *et al.* (2009) found that nearly one third of women drank alcohol at some time during pregnancy.

Abortion attempts were admitted by almost 10% of the women. Induced abortion is not legally allowed in Brazil but nonetheless it is quite common practice (Faundes, 2010). Other risk factors present during pregnancy or delivery were concordant with literature data for Brazil (Momino *et al.*, 2003).

The multiple logistic regression test revealed three variables as related to maternal drinking behavior during pregnancy. These were criminality among relatives, being abused

**Table 4** - Height, palpebral fissures length and inner canthal distance measures, and cognitive performance in individuals of European and African ancestry.

Variable	European Ancestry						African ancestry				
	FASE (n = 118)			Controls (n = 57)			FASE (n = 31)		Controls (n = 47)		
	Mean	SE		Mean	SE	p	Mean	SE	Mean	SE	p
Right palpebral fissure	168.49	0.653		170.08	0.912	0.156 <sup>†</sup>	168.98	1.424	169.91	1.137	0.610 <sup>†</sup>
Left palpebral fissure	2.75	0.019		2.67	0.026	0.014 <sup>†</sup>	2.82	4.026	2.79	3.162	0.616 <sup>†</sup>
Inner canthal distance	2.76	0.019		2.68	0.026	0.025 <sup>†</sup>	2.82	4.004	2.79	3.145	0.529 <sup>†</sup>
Philtrum length	3.16	0.026		3.10	0.036	0.192 <sup>†</sup>	3.26	4.789	3.20	0.038	0.332 <sup>†</sup>
Intelligence points	33.73	0.942		39.03	1.321	0.001 <sup>†</sup>	31.96	1.939	34.45	1.539	0.317 <sup>†</sup>

Height is expressed in cm; IQ points according to Raven's standard progressive matrices.

<sup>†</sup>Analysis of variance SE: standard error.



during infancy, and a positive history of alcoholism in another member of the family. Domestic violence against the woman was inversely correlated to drinking behavior. Our hypothesis is that domestic violence means that the woman was beaten by her husband mostly when he was drunk, thus generating in the woman avoidance to the use of alcohol.

To obtain an accurate maternal history of alcohol consumption is not always easy or possible. In this sense we tried to detect individuals with FASD regardless of maternal information by using physical signs and neurobehavioral data only. To do so we compared the measurements of the physical examination and the intelligence points of the institutionalized males with those of the public schools students. We opted here to use the percentile for height and head circumference.

Most of the physical measurements showed a significant difference between those two groups regardless of the maternal use of alcohol. Height and philtrum length were affected as expected by a stronger exposure to alcohol among the institutionalized adolescents. Even though the achievement on Raven Progressive Matrices was not different between probands and controls, the very poor results presented by the institutionalized boys are worthy of note, with 35 points being considered the low end of the normal intelligence curve. The low height and low intelligence scores are very heterogeneous in their etiology and therefore with low specificity for prenatal alcohol exposure.

Palpebral fissures, however, were significantly smaller in the control group, which was in the direction opposite from the expected. The fact that the difference was observed only in individuals of European ancestry could be contributing to this result, but we cannot yet explain why.

In conclusion, we could not identify in this sample of adolescents, individual cases with a clear diagnosis of FAS, but signs suggestive of FASD were more common in institutionalized adolescents. The high maternal history for drinking in both groups is also noteworthy. Furthermore, social factors like domestic and familial violence, which are frequent in this group, are also predictors of maternal drinking during pregnancy. From the herein compiled information the inference is that in Brazil criminal behavior is more related to complex interactions among environmental and social issues, these including prenatal alcohol exposure.

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